Technical Design History of Russian Neutron Bombs: Contributions of VNIITF and Boris Litvinov

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Abstract

This article provides a technical overview of the design history of Russian neutron bombs, focusing on the contributions of the All-Russian Scientific Research Institute of Technical Physics (VNIITF) in Snezhinsk and the work of chief designer Boris Litvinov. Drawing on primary sources, including Litvinov's *Selected Works* and declassified Soviet reports, the article details the evolution of neutron bomb technology from the 1960s to the 1980s, emphasizing key milestones in miniaturization, low-fission thermonuclear designs, and tactical delivery systems. The focus is on factual technical developments, excluding discussions of the bombs' effects or associated political narratives.

1 Introduction

Neutron bombs, or enhanced radiation weapons (ERWs), are a class of thermonuclear devices designed to maximize neutron radiation output while minimizing blast and thermal effects. In the Soviet Union, the development of neutron bombs was led by the All-Russian Scientific Research Institute of Technical Physics (VNIITF) in Snezhinsk, with significant contributions from chief designer Boris Litvinov. This article traces the technical design history of Russian neutron bombs, focusing on the period from the 1960s to the 1980s, when key advancements were made in fusion-driven designs and tactical delivery systems.

2 Early Foundations: 1963–1976

The groundwork for neutron bomb development at VNIITF was laid during the 1963–1976 period, as detailed in Litvinov's *Selected Works* [1]. This era followed the 1963 Moscow Treaty, which banned atmospheric, underwater, and space nuclear tests, forcing the Soviet Union to shift to underground testing. The transition posed technical challenges, including yield limitations (from 50 Mt TNT equivalent in atmospheric tests to 4–5 Mt in underground tests) and the need for new infrastructure like tunneling and drilling [1].

Figure 1: 152mm Russian nuclear artillery shell; yield 2.5 kt. The enhanced neutron version had total yield just 0.8 kt.

2.1 Miniaturization of Nuclear Charges

Under the scientific leadership of Evgeny Zababakhin, VNIITF prioritized the miniaturization of nuclear charges, particularly primary charges, to enable compact thermonuclear designs [1]. In 1964, VNIITF developed a miniature charge for a 280 mm caliber, inspired by the U.S. Davy Crockett tactical rocket. This charge used a new plastic explosive composition developed under P.K. Panov, replacing the solid explosive used at VNIIEF (Sarov). The charge was tested in March 1965, becoming the smallest-caliber atomic charge in the USSR at the time [1].

2.2 Low-Fission Thermonuclear Designs

A significant milestone occurred in February 1965, when an experiment proposed by Zababakhin, Lev Feoktistov, Evgeny Avrorin, and A.A. Bunatyan achieved the burning of a deuterium-tritium (D-T) mixture outside the primary charge [1]. This demonstrated the feasibility of fusion-driven devices with minimal fission, a key requirement for neutron bombs. The experiment led to the development of a primary nuclear charge with low fission activity, a transition device to powerful secondary thermonuclear charges operating on gaseous deuterium, and an irradiating nuclear explosive device for physical experiments [1].

In 1972, VNIITF tested a thermonuclear device with a yield over 100 kt TNT equivalent, achieving a fission activity of only a few tens of grams—ten times less than the 1965 Chagan test by VNIIEF [1]. This focus on minimizing fission activity was critical for neutron bomb designs, which rely on fusion to produce neutron radiation.

2.3 Tactical Delivery Systems

VNIITF developed nuclear charges for artillery systems, including 152 mm and 203 mm shells and 240 mm mines, which were adopted by the Soviet Army [1]. The 152 mm shell, in particular, became a focus for neutron bomb development. By 1975, Litvinov's team had created the smallest nuclear charge for a 152 mm artillery shell, laying the groundwork for tactical neutron bomb delivery [2].

3 Development of the Neutron Bomb: Late 1970s

Building on the 1963–1976 advancements, Litvinov led the development of the Soviet Union's first operational neutron bomb in the late 1970s [2]. The design focused on maximizing fusion energy while minimizing fission, achieving a yield of approximately 1 kt TNT equivalent, with 80% of the energy derived from fusion and less than 20% from fission [2]. The high fusion-to-fission ratio was achieved by optimizing the D-T reaction, using a small fission trigger to initiate a fusion reaction that produced a significant neutron flux.

The neutron bomb was designed for tactical use, specifically for 152 mm artillery shells and short-range missiles like the SS-21 Scarab [2]. The choice of artillery shells allowed for rapid, precise deployment on the battlefield, aligning with the Soviet focus on ground-based tactical systems.

4 1981 Neutron Bomb Test at Novaya Zemlya

A key milestone in the Soviet neutron bomb program was a test conducted in 1981 at Novaya Zemlya, as documented in declassified Soviet reports [2]. The test involved a 152 mm artillery shell delivering a neutron bomb with a yield of 0.8 kt TNT equivalent. The device maintained the 80% fusion energy ratio, with the remaining 20% from fission, ensuring a high neutron output. The test likely occurred in September or October 1981, based on typical Soviet testing schedules at Novaya Zemlya and the geopolitical context of U.S. neutron bomb production restarting that year [2, 3].

The test was conducted underground in Zone B (Matochkin Shar) of Novaya Zemlya, a site used for underground tests from 1964 to 1990. The use of a 152 mm shell, compatible with standard Soviet artillery like the 2S3 Akatsiya, underscored the tactical focus of the neutron bomb program.

5 Deployment and Delivery Systems

By the 1980s, the Soviet Union had deployed neutron bombs in 152 mm artillery shells and SS-21 Scarab short-range missiles [2]. The artillery shells were designed for battlefield deployment, allowing for rapid response in tactical scenarios. The SS-21 Scarab, a mobile missile system with a range of 70–120 km, provided additional flexibility for delivering neutron bombs over longer distances.

There is no evidence in the sources that the Soviet Union developed neutron bombs for larger aircraft-delivered systems. While aircraft delivery was used for strategic weapons like the RDS-3 (52 kt, 1951) and the Tsar Bomba (50 Mt, 1961) [4, 5], the neutron bomb's tactical role favored ground-based systems like artillery and missiles.

6 Conclusion

The design history of Russian neutron bombs reflects a systematic effort at VNIITF, under Boris Litvinov's leadership, to develop compact, fusion-driven nuclear charges for tactical use. From the 1960s to 1970s, VNIITF focused on miniaturization, low-fission thermonuclear designs, and artillery-compatible charges, culminating in the first operational neutron bomb in the late 1970s. The 1981 test at Novaya Zemlya, using a 152 mm artillery shell with a 0.8 kt yield, marked a significant achievement. The Soviet neutron bomb program prioritized ground-based delivery systems, specifically 152 mm shells and SS-21 missiles, over aircraft-delivered weapons, reflecting its tactical focus.

References

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